Master Your Multi-scale Challenge.

ZEISS Atlas 5

Your Solution for Automated Image Acquisition, Data Correlation and Multi-modal 2D & 3D Workflows

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ZEISS

Seeing beyond

Your Solution for Automated Image Acquisition, Data Correlation and Multi-modal 2D & 3D Workflows

Atlas 5 makes your life easier: create comprehensive multi-scale, multi-modal images with a sample-centric correlative environment.

Atlas 5 is the powerful yet intuitive hardware and software package that extends the capacity of your ZEISS scanning electron microscopes (SEM) and focused ion beam SEMs (FIB-SEM). Use its efficient navigation and correlation of images from any source. Take full advantage of high throughput and automated large area imaging. Unique workflows help you to gain a deeper understanding of your sample.

Its modular structure lets you tailor Atlas 5 to your everyday needs in materials or life sciences research. Extend your possibilities even further with modules e.g. for nanopatterning or array tomography.

Discover highlights of Atlas 5.

Simpler. More Intelligent. More Integrated.

Acquire Nanoscale EM Images Easier and Faster than Ever Before

Acquire large sets of 2D or 3D nanoscale electron microscope (EM) images for hours, or even days, without operator supervision. Capitalize on Atlas 5's high throughput: automatic acquisition leaves you free to focus on results. Collect single images over thousands of samples, or cover large areas with mosaics comprised of thousands of adjacent images. Atlas 5 streamlines automatic image acquisition, using advanced presets and customizable protocols to produce consistent and reproducible results.

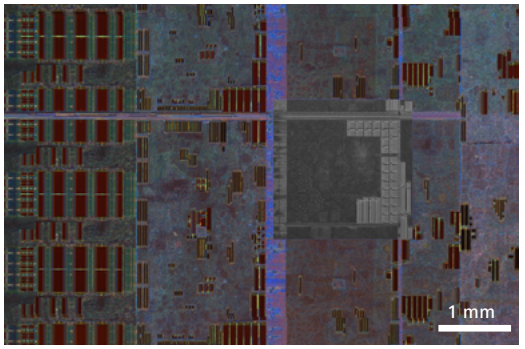
Correlate Images in Multiple Dimensions from Multiple Sources

Atlas 5's correlative workspace makes it easy to bring together images from multiple sources: zoom in from the full macroscopic view of your sample down to nanoscale details. Atlas 5 is the efficient way to analyze and correlate images from multiple sources – a powerful data hub that works with images from SEM, FIB-SEM, X-ray microscopes, light microscopes and any optical images, even from your digital camera. Its sample-centric workspace lets you build a seamless multi-modal, multi-scale picture of your sample. Use it to guide further investigations and target additional acquisitions.

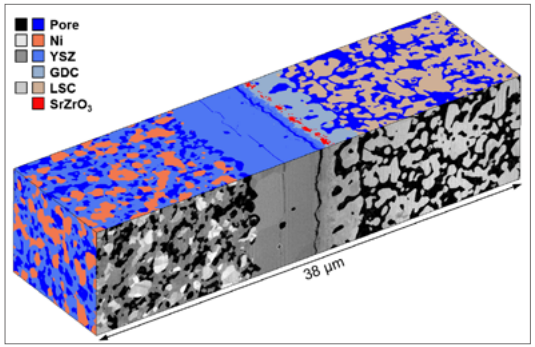
Understand Your Sample by Creating Unique Workflows

Understand your sample fully in both 2D and 3D. Atlas 5 employs a novel graphical user interface concept that makes it easy to investigate all your samples. Design a workflow tailored precisely to the complexity of your experiment, no matter whether it's a simple one-step task or a compound experiment. A sophisticated workflow environment guides you all the way from the setup for automated acquisition to post-processing and customized exports, and right on through to analysis.

Easy-to-use, workflow-oriented GUI (graphical user interface) for automated imaging. Fossiliferous carbonate sandstone sample. Sample: courtesy of D. Schumann, Fibics Incorporated, Canada.



Light microscope and SEM images of an integrated circuit are merged in the Atlas 5 correlative workspace.



Microstructural changes after cycling of a solide oxide electrolysis cell were studied using the 3D Tomograhpy and the Analytics module on a ZEISS FIB-SEM. The volume of interest shows a combination of 3D images with 3D EDS data. Sample: courtesy of M. Cantoni, EPFL Lausanne, Switzerland

Your Insight into the Technology Behind It

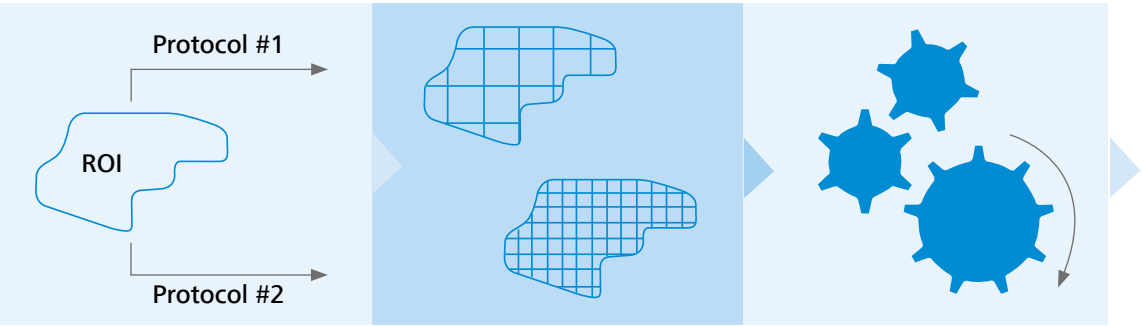
Maximize Productivity – Acquire Nanoscale Images Easier and Faster than Ever Before

Automated 2D and 3D image acquisition lets you maximize productivity and ensure maximum use of your microscope, too. The xROI (exact region of interest) tools define the area you want imaged so you will save time as predefined protocols scan only your designated regions of interest. Atlas 5 allows you to put sophisticated imaging protocols in place to control your acquisitions. That means you will get consistent, reproducible results with built-in recordkeeping for future reference. You can develop protocols to manage ideal imaging conditions efficiently across resolutions, sample types and multiple users in an imaging facility. Choose from the entire range of detectors and set imaging parameters to suit your sample and specific application needs. Now you can take full advantage of a new automated workflow that's tailored especially to STEM applications over multiple grids. Atlas 5 assesses whether an area can be covered by a single image or will have to be acquired as a mosaic of many images. Advanced autofocus and auto-stigmation keep the images sharp over even the longest acquisitions, and can be tuned to work reliably on the most challenging samples.

Acquire Images in Multiple Sessions on Multiple Instruments

Atlas 5 supports multiple sessions, giving you the flexibility you need to image your sample whenever and wherever you wish. You can image a sample on the same microscope at various times when beam time is available, or move your sample to different microscopes as required. Survey a sample in your SEM, then move it to your ZEISS Crossbeam to perform FIB-SEM 3D data collection at precise locations based on the SEM imagery. You can do all of this as a single project in Atlas 5.

Acquisition Workflow

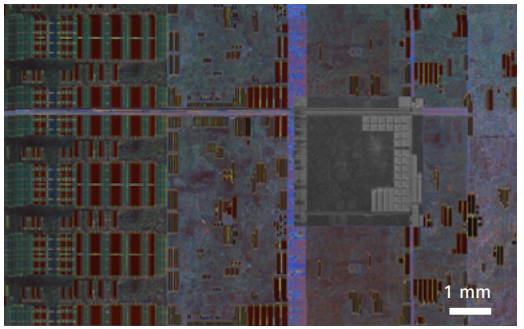


1. Focus on results with intelligent protocols and xROI.

2. Develop and apply imaging protocols for overview and high resolution imaging.

3. Automatic Acquisition

Set up your experiment and acquire your imagery in three steps. Atlas 5 automatically acquires mosaics and images over the regions you draw based on the protocol you select.



Light optical images and automatically acquired high resolution SEM images on selected regions on an integrated circuit.

Your Insight into the Technology Behind It

Correlate Images in Multiple Dimensions from Multiple Sources

Atlas 5 provides a sample-centric correlative workspace where you can bring together 2D images and 3D volume data from multiple instruments. Built as a state-of-the-art tool for managing large amounts of 2D and 3D images in one spot, Atlas 5 lets you import and align data from light, X-ray, electron and FIB-SEM microscopes to produce a single, consistent picture of your sample. Now you can see correlations between features visible in the different sources, visualize across multiple scales and guide further investigation and acquisition. Your EM images can guide you to places in the sample for further analytical analysis in both 2D and 3D (as EDS or 3D EBSD). In addition, take advantage of ZEISS Shuttle & Find to correlate with your ZEISS light microscopes: Atlas 5 keeps it simple.

Acquire Nanoscale EM Images Easier and Faster than Ever Before

Atlas 5 gives you a quick solution for generating and processing huge amounts of data. As demand increases for analyzing large sample areas or thousands of sites at nanometer resolution, you can visualize more than a terabyte of images in a single project. Atlas 5 includes powerful, efficient tools to correct, export and share the large amounts of data you collect. Flexible export options let you access data as acquired, or produce down-sampled, cropped, corrected image exports for other purposes. You can even export massive mosaics to its Browser-based Viewer so that anyone with a standard web browser can view your entire dataset at full resolution. And you can do all of this at the microscope or at your desk.

Automatic acquisition of multi-scale SEM images. Serial sections of optical nerve tissue. Sample: courtesy of J. Lichtman, Molecular and Cellular Biology, Harvard University, US.

Export to explore a 25 gigapixel SEM image of this coin online

Your Insight into the Technology Behind It

Correlate with X-ray Microscopy to Precisely Target Sub-Surface Sites in FIB-SEM

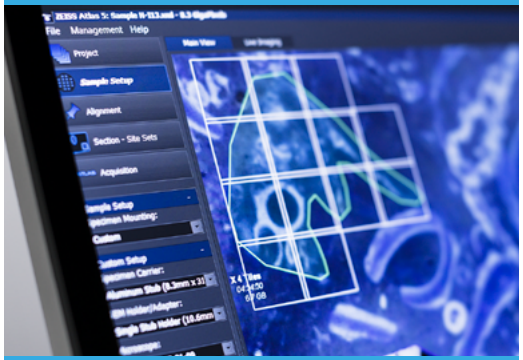
Atlas 5's correlative workspace lets you correlate X-ray microscopy volume scans from your ZEISS X-ray microscope with surface features visible in your FIB-SEM. Use the X-ray data to virtually localize sub-surface features in 3D to precisely target FIB sites at features of interest – even if the features are not visible on the sample surface. Then navigate to those regions with confidence using your ZEISS Crossbeam. Launch the Atlas 5 3D Tomography module to collect the highest resolution volume images of the exact features of interest you have identified. This significantly amplifies the efficiency of FIB-SEM tasks.

Resolution in 3D with Your FIB-SEM

Profit from accurate and reproducible results by reaching below 10 nm isotropic voxel size in 3D with your FIB-SEM. The Atlas 5 3D Tomography Module's powerful sample-tracking technology automatically corrects the sample drift while also measuring slice thickness with true accuracy. Collect precise 3D data automatically with consistent slice thickness over long acquisitions. Meanwhile robust autofocus and auto-stigmation algorithms keep all of your images sharp.

X-ray Tomography
Locate ROI

ZEISS Atlas 5
Register, navigate and drive FIB-SEM to ROI



FIB-SEM Tomography
Efficiently re-locate ROI

Expand Your Possibilities

Get Better Results, Faster

At the microscope or at your desk, you have the tools you need to get better results in less operator time for all your demanding applications.

- Automated stitching tools let you pull tile-based acquisitions into seamless single images that can be more than a terapixel in size. You have complete control of the results and benefit from the automatic corrections.
- Apply batch stitching to previously acquired mosaics while still using the system to acquire new images.
- Image correction tools let you fix imaging irregularities in individual images or across entire mosaics.
- You can process information from multiple channels, detectors or sources into composite images.
- Flexible export options give you access to the exact pixel data as acquired, or produce down-sampled, cropped, corrected image exports or movies for other purposes.
- Export to the Browser-based Viewer and anyone with a standard web browser can view your entire dataset at full resolution.
- Stitching, correction and export tools can be applied to datasets from previous versions of Atlas.

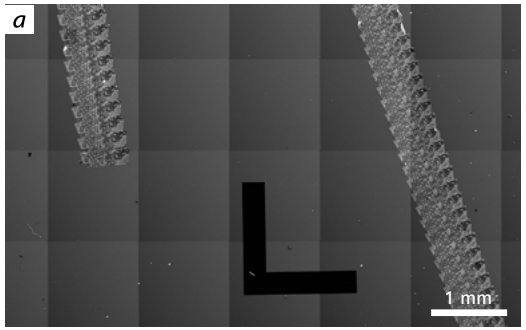
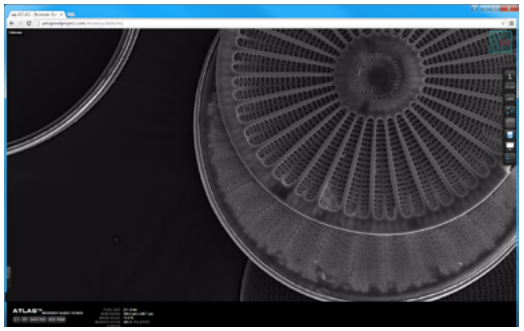
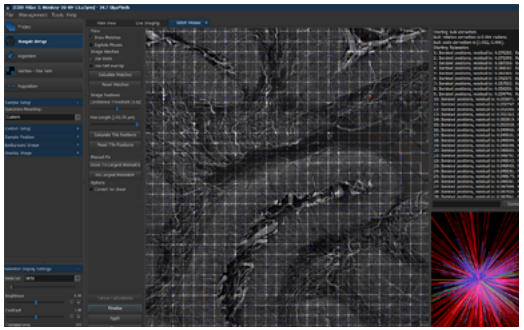


Image correction tools allow you to correct for imaging artifacts a) before and b) after.



Share your data online at full resolution with the Browser-based Viewer.



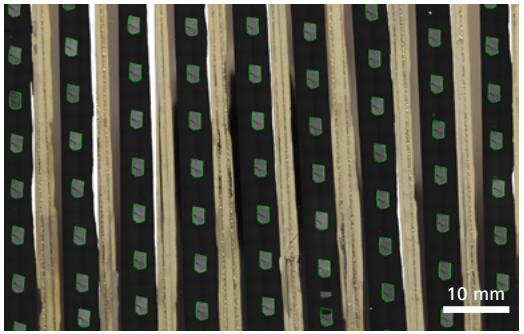
Stitch the largest mosaics into seamless single images with advanced automatic stitching tools.

Expand Your Possibilities

Array Tomography Module:
The Fast and Efficient Solution for Imaging Your Serial Sections

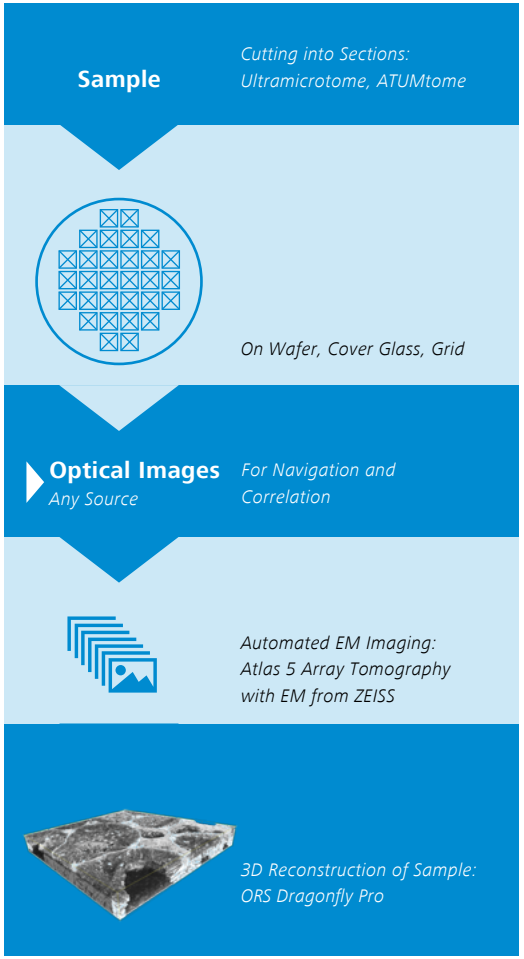
The Array Tomography Module lets you set up, acquire and export electron microscope image stacks of serial sections quickly and efficiently. This software module is a highly productive tool for automated imaging of biological serial sections to enable 3D visualization of large volumes:

- Work with light microscope data for correlative workflows. Import datasets of light optical images acquired with ZEISS ZEN Correlative Array Tomography, our unique software module that lets you acquire LM images of serial sections. It's designed to detect and mark the outlines of your sections automatically, then transfer them as regions of interest for further image acquisition at nanometer resolution in the SEM, using Atlas 5. In this way you will be maximizing your correlative experiment.
- It's the quick and efficient way to identify your sections and, optionally, sites of interest across ranges of sections.
- Section identification can be automated with image correlation tools specifically developed for hundreds of automatically prepared serial sections, prepared by an ATUMtome.
- Automatically acquire image sets of sections or sites using built-in protocols specifically tailored to life science applications – no operator supervision required.
- Stack alignment for the acquired image sets is available.
- Export image stacks efficiently at full resolution or cropped and down-sampled for equally efficient 3D reconstruction in tools such as ORS Dragonfly Pro software.



Identify serial sections quickly and perform an easy setup for automated array tomography applications.

Array Tomography Workflow



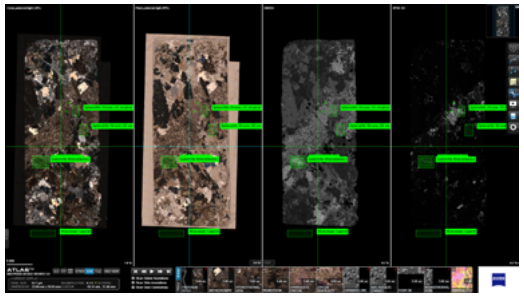
Expand Your Possibilities

Enhanced Browser-based Viewer Export Module: Analyze, Present and Share Results—or Use It to Train Colleagues and Students

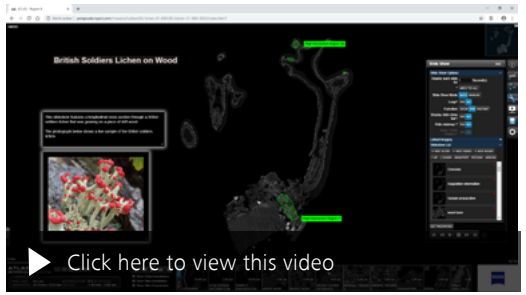
Being able to see all correlative data of your dataset at a glance gives you the advantage of simultaneous visualization of all modalities. This Browser-based export module lets you exploit the correlative approach at its best, especially as you start your final analysis and report. Use it to present and share your results with research fellows or students. It's ideal for measurements, data export and creating annotated slide shows—as well as for training and education.

Consider the Benefits:

- Export single or multiple datasets to a format that can be viewed in a regular web browser.
- Freely explore the dataset at its best resolution with full pan and zoom functionality.
- Share all data and allow others to view it by simply exchanging flash drives or hosting it on a server—no need for an Atlas installation.
- Present all correlated data in a comprehensive way and highlight features by creating curated slideshows. It's easy to embed clips, image files, PDFs and other information, and to add annotations.
- Follow the slideshow as it unfolds or pause at any time to explore the data on its own.
- Perform measurements for final analysis and reporting.
- Give your students, colleagues and fellow researchers the power of digital education.



Polished petrographic thin section, investigated with multiple modalities e.g. light microscopy and a ZEISS FE-SEM (field emission). Sample: Peralkaline granite from Northern Quebec. Sample courtesy of: A. Gysi. The dataset was acquired and processed by Dirk Schumann at Fibics Incorporated, Ottawa, Canada.

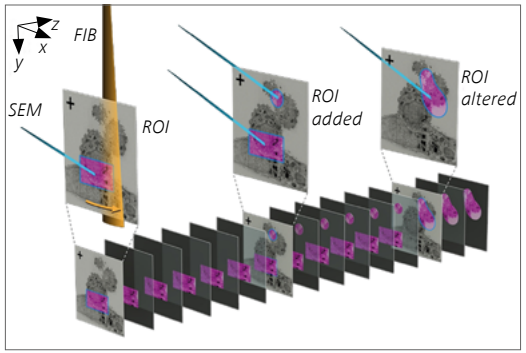


Slideshow showing an investigation of a longitudinal cross-section of a British soldiers lichen (Cladonia cristatella). In the slideshow you are able to share additional information like headlines or subscripts. Images acquired with a ZEISS FE-SEM. Image courtesy of: Fibics Incorporated, Ottawa, CA.

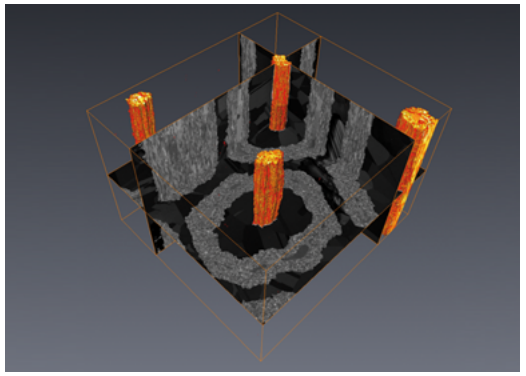
Expand Your Possibilities

3D Tomography Module:
Maximum Throughput for Your FIB-SEM Nanotomography Applications

Automatically create 3D data stacks up to several thousand images per stack. The 3D Tomography module allows you to analyze sample volume from thousands to millions of cubic micrometers with nanometer resolution in all three dimensions. Intelligent software algorithms reduce the amount of data and the time needed for 3D volume acquisition. Precise drift correction, auto-stigmation and autofocus give you fast and reliable automation. Adaptive SEM-based 3D tracking of both the FIB and SEM beam results in precisely measured slice thickness of a nanotomogram throughout the entire acquisition process, yielding optimized results. Use high resolution xROIs combined with periodic Key Frame overview images of your sample's entire cross-section, enabling collection of simultaneous multi-resolution datasets. Carry out high resolution milling and imaging simultaneously, and without requiring time-intensive stage movement.



Automated FIB-SEM Nanotomography: Acquire simultaneous multi-resolution datasets using xROI and Key Frames. Courtesy of: K. Narayan and S. Subramaniam, National Cancer Institute, National Institutes of Health, Bethesda, MD, USA.



Still image of a volume rendering of a niobium tin multi-filament superconducting cable in a copper matrix, derived from a three-dimensional dataset of approximately ten billion 10 × 10 × 10 nm voxels. Sample: courtesy of M. Cantoni, EPFL, Switzerland.

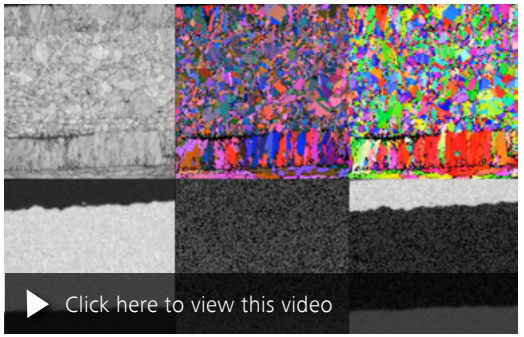
Expand Your Possibilities

Analytics Module: Add Comprehensive Elemental and Crystallographic Information in 3D

3D FIB-SEM experiments let you investigate the internal structure of samples after slicing and imaging a volume of interest on a nanoscale. Profit from Atlas 5's unique capability to precisely track the slice thickness in the nanometer range. You can add information about elemental composition or crystallography to your experiment by using EDS (energy dispersive x-ray spectroscopy) or EBSD (electron backscatter diffraction). The EDS or EBSD maps can be acquired at a different set of beam parameters thus assuring ideal conditions for the chosen analytic technique without sacrificing resolution during the imaging. Just consider the benefits of having these analytical methods fully integrated into your 3D workflow. Besides switching of beam conditions all necessary stage moves in case of 3D EBSD are automated, too. Alternatively you can benefit from having EBSD in the static configuration: With the EBSD camera mounted in "static" configuration, it is possible to have FIB milling, high-resolution SEM imaging and EBSD mapping at the same sample position. No stage moves are necessary. Atlas 5 is completely compatible with this variant of the workflow, which enables faster and more stable analytic tomography runs.

Use Atlas 5's Analytics Module on FIB-SEMs to:

- Enable high resolution 3D SEM imaging and 3D EDS/EBSD mapping, in the order of hundreds of maps and thousands of images, using two different sets of SEM and EDS/EBSD conditions optimized for each task.
- Tailor the spatial increments for images and maps independently of each other.
- Set up the best landing energies for each modality using a user-friendly workflow, which will then switch automatically between imaging and EDS or EBSD analysis.
- Increase throughput and save data storage by defining and deciding where and how to investigate specific sites with EDS or EBSD, because image and map resolutions, as well as z spacing of the slices, are independent.
- Visualize simultaneous views of SEM images and processed elemental or crystallographic maps.



3D Tomography & Analytics of a Multi-layered Metal System Canadian coin, typical FIB-SEM workflow combining milling, imaging, EBSD (top in this video) & EDS (bottom).

For 3D segmentation and volume reconstruction ZEISS recommends an advanced analysis and visualization software solution, ORS Dragonfly Pro Advanced. Spatial and elemental information can be observed as two individual datasets or they can be flexibly merged to give the most effective understanding, well beyond the limits of single datasets.

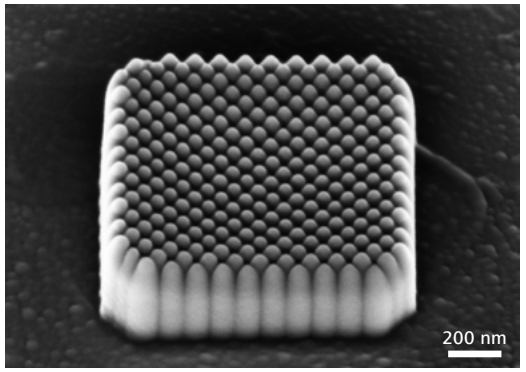
Use Atlas 5's Analytics Module on SEMs to:

- Integrate 2D EDS mappings into your workflow.
- Select regions of interest (ROIs) for 2D EDS mappings.
- Automatically acquire multiple selected ROIs.

Expand Your Possibilities

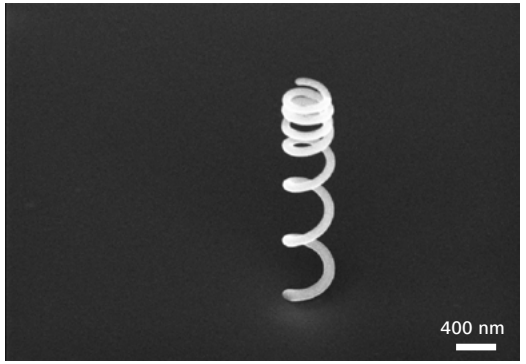
Advanced NanoPatterning & Visualization Engine (NPVE Advanced) Module

Simple to learn yet extremely powerful, the NPVE Advanced module is your solution of choice for a wide range of nanopatterning applications. It's easy to use, allowing even novice users to begin solving complex problems in nanoprototyping quickly – with or without gas chemistry. As an add-on to your ZEISS FIB-SEM, the NPVE Advanced module enables rapid prototyping of structures from nanometers to millimeters in size. The module provides not only precise simultaneous control of your beam(s) for patterning, but also patterning parameters with real-time visualization of the patterning operation from the perspective of each beam. Advanced Operation Recipes make it simple to control all patterning parameters and sequences for each shape, giving you complete control of your beam(s). This includes Fastmill, a special scanning strategy that allows you to prepare FIB cross-sections faster and more efficiently, saving up to 40% milling time. A suite of tools such as Advanced Set Operations, the Array Builder and Digital Lab Book allow you to design and execute experiments to optimize your results quickly.

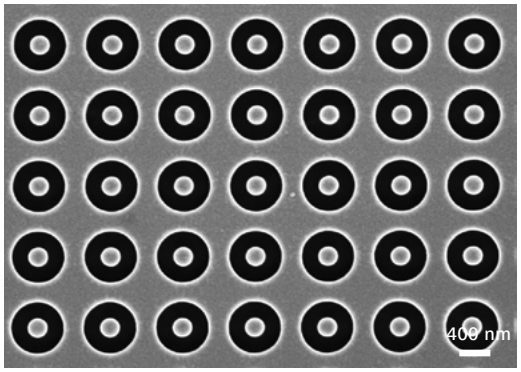


A 1 µm × 1 µm square of pillars has been formed from silicon oxide using Electron Beam Deposition with a 45° patterning angle, chosen to have the pillars just contacting.

A FIB grayscale rendering of the Lincoln Memorial is patterned into silicon with the FIB beam. An unmodified photograph was used as the data source. Patterning time: 10 minutes.



FIB deposition has been used to form a 3D 'wire', 120 nm in diameter, in the shape of a coil 600 nm in diameter.



In this array of annular shapes, each shape is 650 nm in diameter, with a 1 µm spacing (pitch) between the shapes.

Tailored Precisely to Your Applications

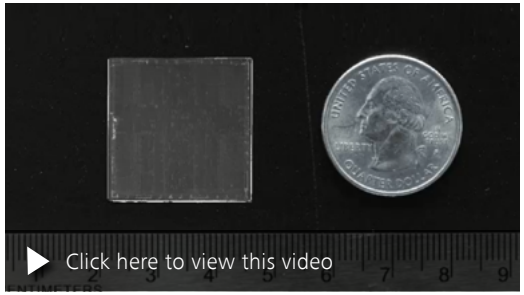
Typical Applications, Typical Samples	Task	ZEISS Atlas 5 Offers
Large Area Imaging	■ Image large areas of the sample surface at high resolution as efficiently as possible for sample characterization or to gather statistics on infrequent features.	Automated acquisition, exact regions of interest (xROIs) and protocol-based imaging all come together in Atlas 5's correlative workspace. Save on setup time with easy-to-use software and execute unattended overnight runs to image large samples. Powerful correction and stitching tools let you export seamless results to the scientific community. Automated STEM imaging of samples on TEM grids. Create overviews of all samples in a STEM holder, select xROI for nm resolution STEM imaging.
Multi-instrument Workflows	■ Manage acquisitions across multiple instruments or at different times to optimize equipment use. ■ Use light microscopical data to guide further correlative EM imaging tasks.	Session-based imaging lets you survey your sample in your SEM, then move to your FIB-SEM to perform 3D data collection at precise locations based on the SEM imagery, all in the same Atlas 5 project.
Imaging Facility Management	■ Enable inexperienced instrument users to get excellent and consistent results.	Configurable protocols and precise auto-focus and autostigmation algorithms let expert users set up recipes that novice users can use to get excellent results without extensive SEM training.
High Resolution Tomography	■ Remove material with the FIB while imaging with the SEM to produce volume data with nanometer resolution voxels.	With the Atlas 5 3D Tomography module, collect FIB-SEM tomography data at high resolution and throughput. Auto-tracking and tuning produce datasets of excellent quality from automated acquisitions over hours or days without operator supervision.
3D Tomography and Visualization on Challenging Samples	■ Achieve 3D visualizations that are based on precise slice thickness measurements. Ensure an accurate, continuous, homogeneous tomogram even of samples sensitive to charging, shrinking or beam damage. ■ Store the thickness measurements together with the images to ensure effective data processing.	Use the "Thin & Fast Tomography" method to reduce shrinking and other artefacts induced by SEM or FIB. Achieve excellent images and eventually accomplish advanced 3D visualizations. Measure and precisely control slice thickness during tomography and achieve "True-Z" information to process your data accurately.
Multi-scale Characterization	■ Use X-ray microscopy data over mm scales to precisely target sites for FIB-SEM analysis over µm scales to upscale characteristics from your high resolution data. ■ Use 3D data from your ZEISS confocal microscope to target sites for FIB-SEM analysis.	Correlate your Versa XRM data with SEM and light microscope images in Atlas 5 to specify and perform FIB-SEM tomography. Use your X-ray tomography or laser scanning microscope 3D data as a subsurface road map for your sample and gather the precise FIB-SEM volumes you need to characterize your sample properly.
Array Tomography	■ Acquire images of automatically or manually prepared serial sections on tape or wafer to perform 3D reconstruction	Acquire overview images and control an automated run to image sections using predefined imaging protocols with the Atlas 5 Array Tomography module. Benefit from image correlation supported tools to define imaging sites within the sections. Easily and automatically replicate imaging sites to cover all sections. Apply alignment algorithms to the acquired image stack in order to compensate drift, rotation or displacement artefacts and facilitate 3D reconstruction.

Tailored Precisely to Your Applications

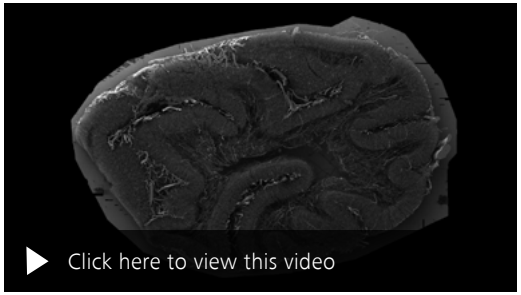
Typical Applications, Typical Samples	Task	ZEISS Atlas 5 Offers
Nanopatterning	■ Pattern the sample surface with the ion or electron beam, with or without the use of gases to assist etching or deposition. Fabricate nano-devices or directly modify circuits or structures.	Create and control complex patterns with extensive geometric and beam control tools using the Atlas 5 Advanced NanoPatterning and Visualization Engine (NPVE Advanced). Intelligent recipes give you precise control of beam and gas parameters for consistent milling and deposition results. Observe FIB operations live with the SEM or visualize details from the perspective of either beam while patterning.
Analytics, EDS, EBSD	■ Go beyond the information revealed by SEM images by integrating 3D EDS or 3D EBSD analysis into your high resolution tomography acquisitions. ■ Minimize stage movements and achieve faster and more precise analytic 3D tomographies. ■ Select sites for 2D EDS based on available images.	Include EDS and EBSD acquisitions using Oxford Instruments detectors and cameras in your high resolution 3D tomography experiment with the Atlas 5 Analytics module. Gather precise elemental or crystallographic information correlated with high resolution image data. Independent EDS/EBSD and imaging energies as well as spatial resolutions maximize quality and flexibility. Acquire 3D tomography datasets in a static configuration for even more stable 3D EBSD runs without any stage moves. Choose sites for 2D EDS mappings based on LM or EM images and acquire EDS maps automatically. Import and display results into Atlas 5 for further correlative analysis.
Evaluate, Present and Share Results	■ Export potentially multi-modal and correlative datasets to allow their exploration at full resolution with free choice of magnification ■ Share data and allow others to view it without the need for an Atlas installation ■ Present image data with additional information in a comprehensive way	Export single or multiple datasets to a format that can be viewed in a regular web browser with the Atlas 5 Enhanced Browser-based Viewer Export module. Let your colleagues, students or peers freely explore the dataset at its best resolution with full pan and zoom functionality. Even measurements and annotations are possible. Share the data easily by exchanging flash drives or by hosting it on a server. Create curated slide-shows based on the data for presentation purposes and embed additional information like pdf files, images, spectra, movies or audio files. The user can follow the slideshow or pause at any time to explore the data on their own.

ZEISS Atlas 5 at Work

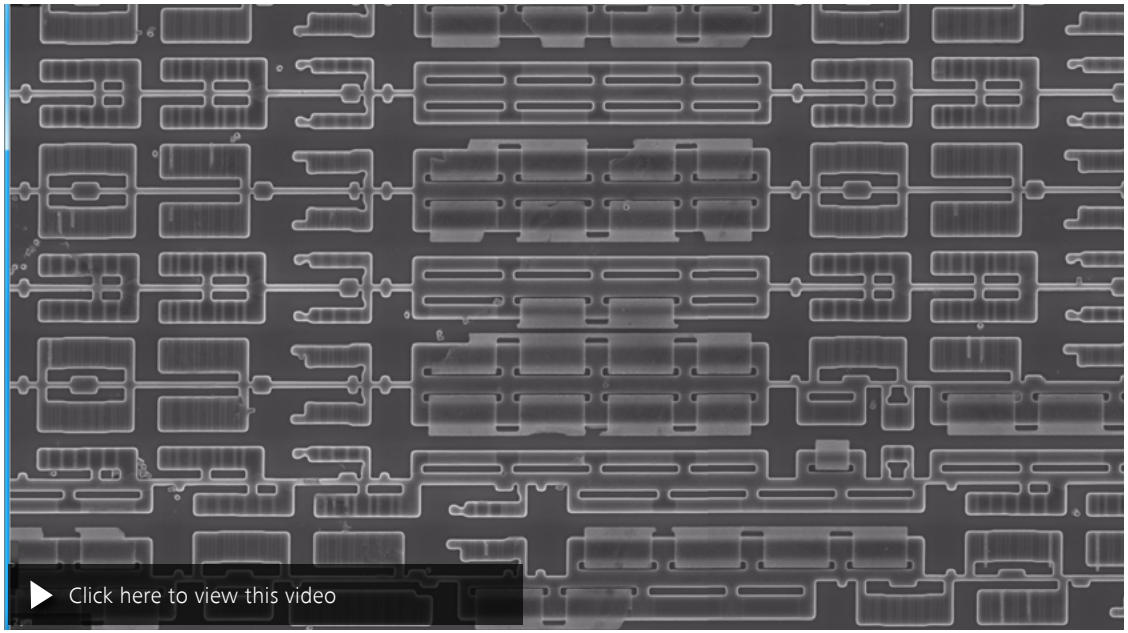
Large Area Imaging



25 mm × 25 mm large area of a computer chip was acquired automatically in 24 hours, resulting in a 1/2 Tera Pixel dataset.



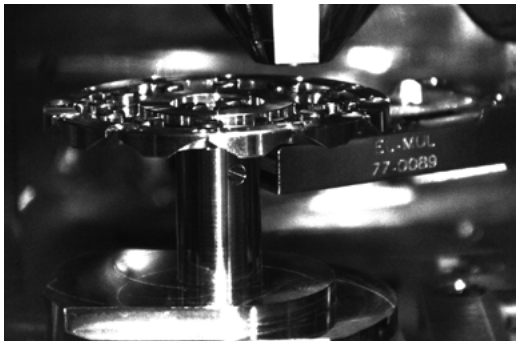
3 cm diameter corrosion cast of circulatory system of a monkey brain. Mosaic of over 1000 images stitched and exported to Browser-based Viewer.



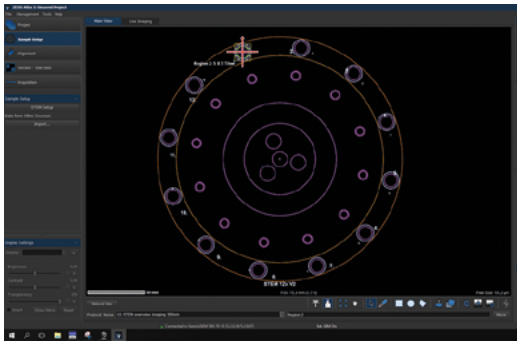
Deprocessed integrated circuit, acquired in 10 hours for a total of more than 90 gigabytes of image data with Atlas 5.

ZEISS Atlas 5 at Work

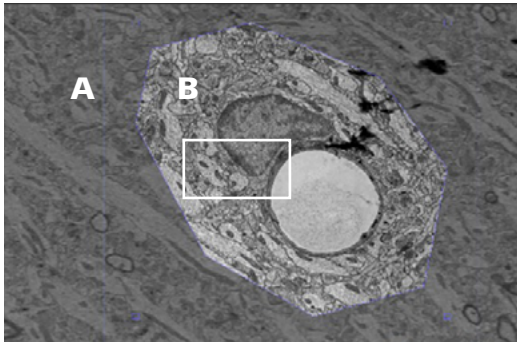
Automated STEM Imaging



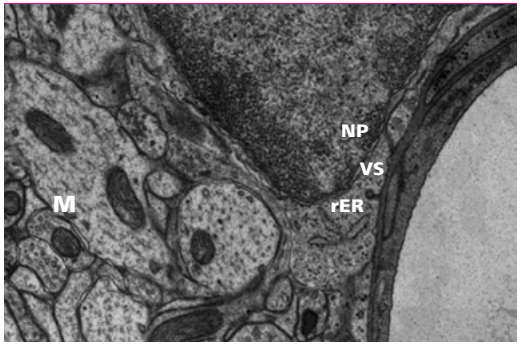
Mount your STEM sample holder for 12 TEM grids into the SEM. Place your STEM detector beneath one of the TEM grids.



Start your new STEM project and easily navigate between samples.



Start imaging with a low resolution overview (A). Follow on by selecting xROIs and image with a higher resolution (B). Sample mouse brain, multi-scale STEM image.



Get the final results from highly resolved image data by zooming into your selected xROIs. Detail of mouse brain, from region B (left). The image shows a magnification of the highlighted rectangle on the left, depicting cellular structures like vesicles with surrounding coatomer (VS), rough endoplasmatic reticulum (rER), nuclear pore (NP) and cristae of mitochondria (M).

Automated STEM Imaging

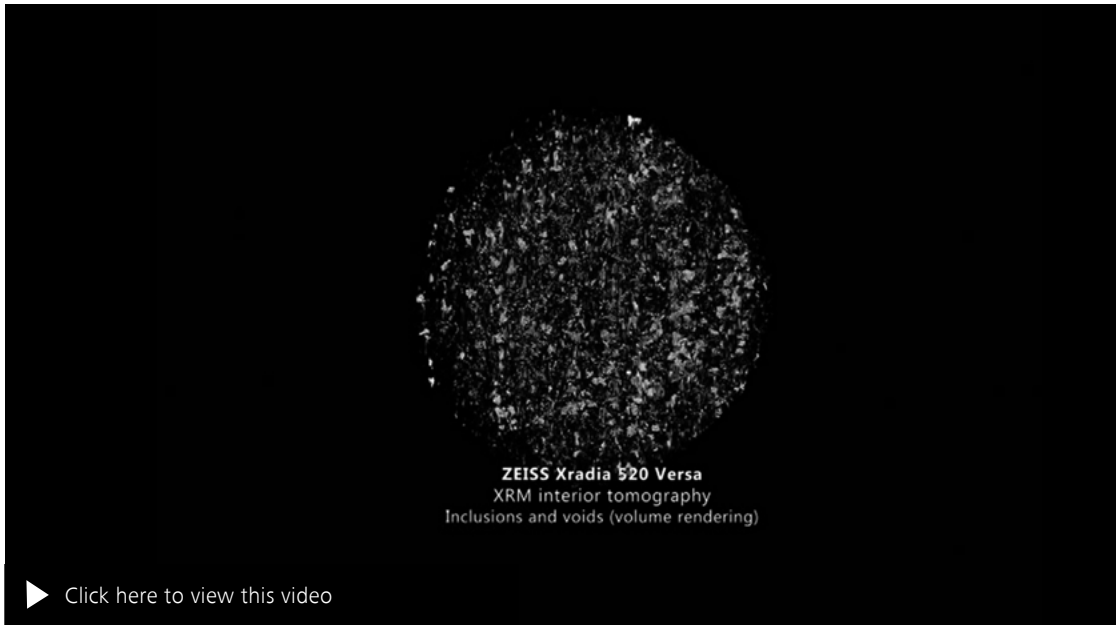
With Atlas 5 you are now able to accelerate your STEM detection. The STEM holder and software are aligned perfectly to each other.

Workflow

- Prepare your sample as you normally do for TEM grids.
- Fix your TEM grids in the multiple STEM grid holder.
- Mount the STEM grid holder into the SEM.
- Set up your STEM experiment and start.
- Locate the single TEM grids automatically, then image them at different resolutions as defined.

ZEISS Atlas 5 at Work

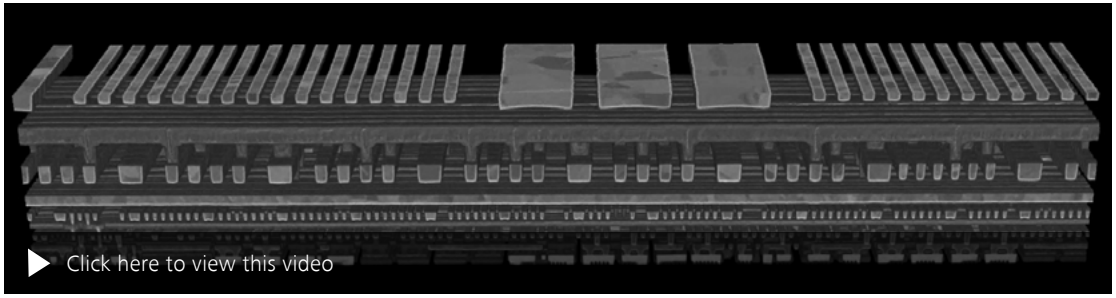
Multi-scale Characterization



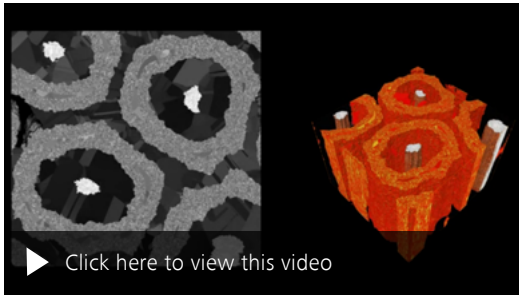
Look below the surface of your sample, using X-ray tomography to drive your ZEISS FIB-SEM. In this ZEISS Atlas 5 project, 2D SEM images and 3D X-ray tomograms of a polished aluminum alloy sample were correlated to identify sub-surface precipitates and voids of interest. The ZEISS Atlas 5 3D Tomography module was then used to acquire high resolution 3D FIB-SEM tomography data on a targeted feature of interest. The project contains over 40 GB of data acquired over two days on three different instruments. Sample: courtesy of N. Chawla and S. Singh, School for Engineering of Matter, Transport, and Energy (SEMTE), Arizona State University, USA.

ZEISS Atlas 5 at Work

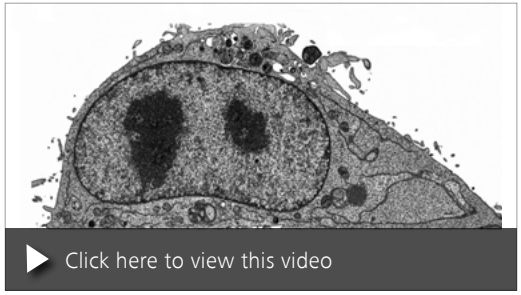
High Resolution Tomography



A portion of a 22 nm Intel Tri-Gate integrated circuit, acquired with 5 nm voxels with Atlas 5. Sample: courtesy of UBM TechInsights.



A data stack of images (left) and a volume rendering (right) of a Nb_3Sn multifilament superconducting cable in a copper matrix, derived from a three-dimensional dataset of approximately ten billion 10 × 10 × 10 nm voxels, acquired with Atlas 5. Sample: courtesy of M. Cantoni, EPFL, Switzerland.

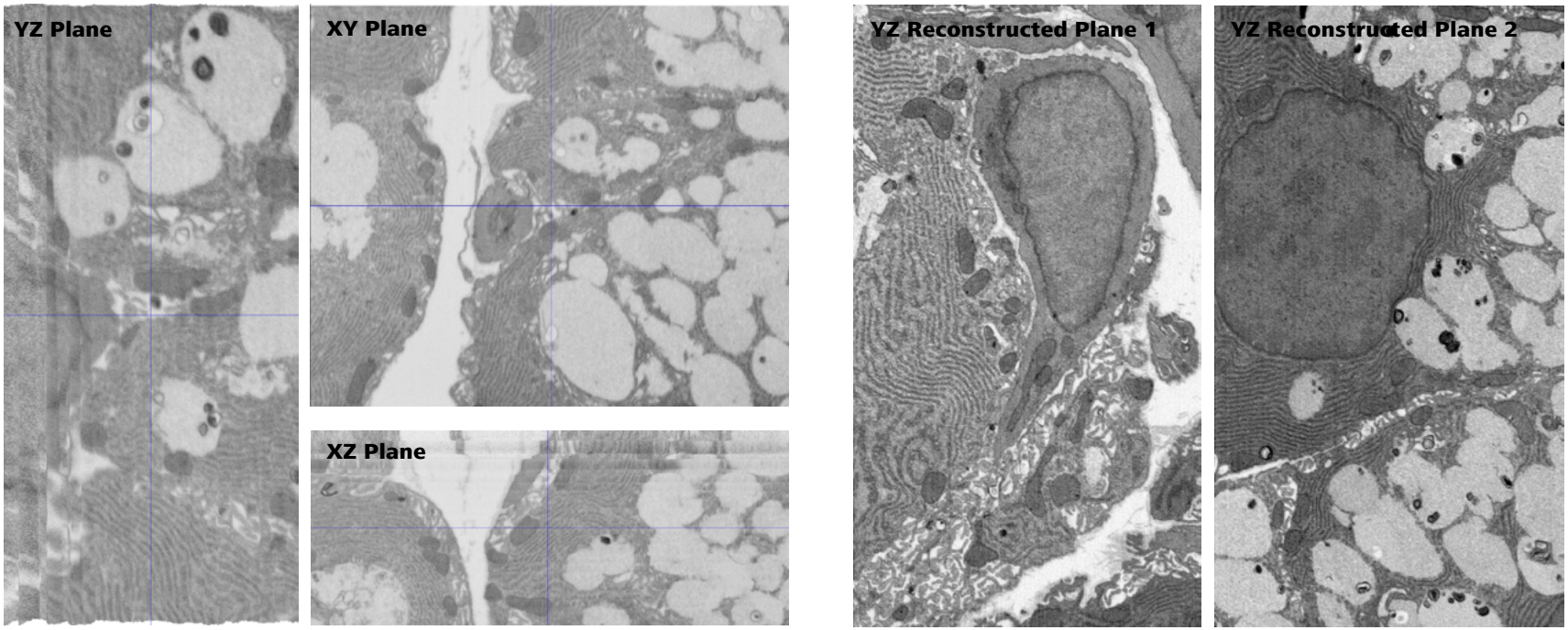


Individual cells grown in a cell culture, chemically-fixed and resin-embedded. Acquired using Atlas 5 3D Tomography at a voxel size of 5 × 5 × 8 nm over a total length of 16 µm. Usage of the EsB detector allows to image ultrastructural details without charging artifacts typical for resin-embedded samples. The video (left) shows a fly-through of 1400 slices. The 3D visualization (right) was done using ORS Dragonfly Pro software. Courtesy of: A. Steyer & Y. Schwab, EMBL Heidelberg, Germany. (Field of view 44 µm × 28 µm).

Caenorhabditis elegans is a model organism for molecular biologists. This dataset was acquired over several weeks using Atlas 5 3D Tomography. More than 10,000 slices of the high pressure frozen and freeze substituted sample were recorded in an automated workflow at a voxel resolution of 5 × 5 × 8 nm.

ZEISS Atlas 5 at Work

Thin & Fast Tomography

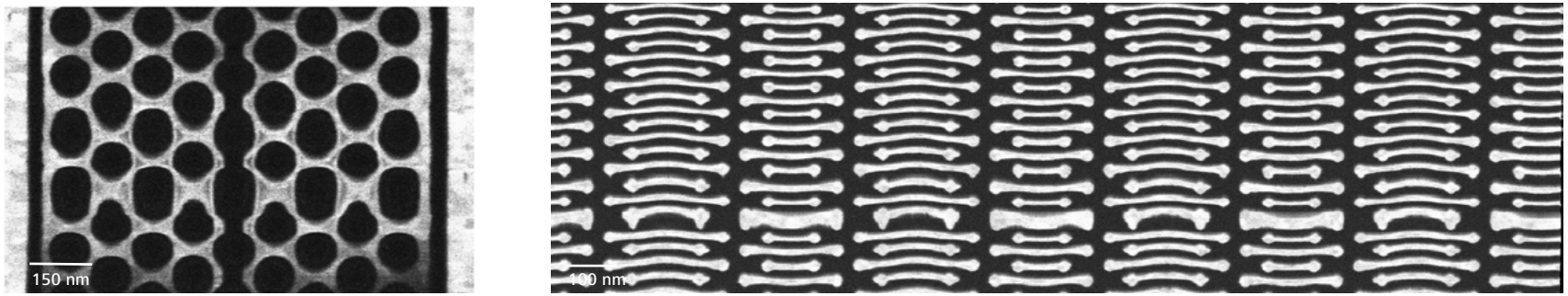


Sensitive samples may be not ideally suited for FIB-SEM tomography, because they might charge, suffer from structural or integral damage, may drift or tend to build up artefacts in case they cannot handle the required SEM and/or FIB doses. Such samples benefit from the Thin & Fast Tomography method, an optimized 3D Tomography approach that reduces shrinking and other artefacts induced by both SEM and FIB. It minimizes the dose applied to each slice while maximizing signal-to-noise on a given sample by scanning extremely thin slices at extremely fast rates. Accurate visualization is provided by using the precise slice thickness measurements along with a binning of multiple slices. In this example FIB-SEM tomography was performed using "standard" beam control for FIB-SEM tomography in Atlas 5 on a challenging resin embedded biological sample of a mammalian salivary gland (left). Acquisition settings: 10 nm/slice at ~1 min/slice. The selected reconstructed virtual image plane views from the standard Atlas 5 3D Tomography dataset show: even with the application of True-Z data processing and multi-point alignment the reconstructed tomograms are not ideal. Better results were achieved by using Thin & Fast Tomography in Atlas 5 3D Tomography (right). Sample courtesy of: K. Narayan, Center for Molecular Microscopy, Frederick National Laboratory for Cancer Research, NCI, NIH USA. Images courtesy of: Fibics Incorporated, Ottawa, Canada.

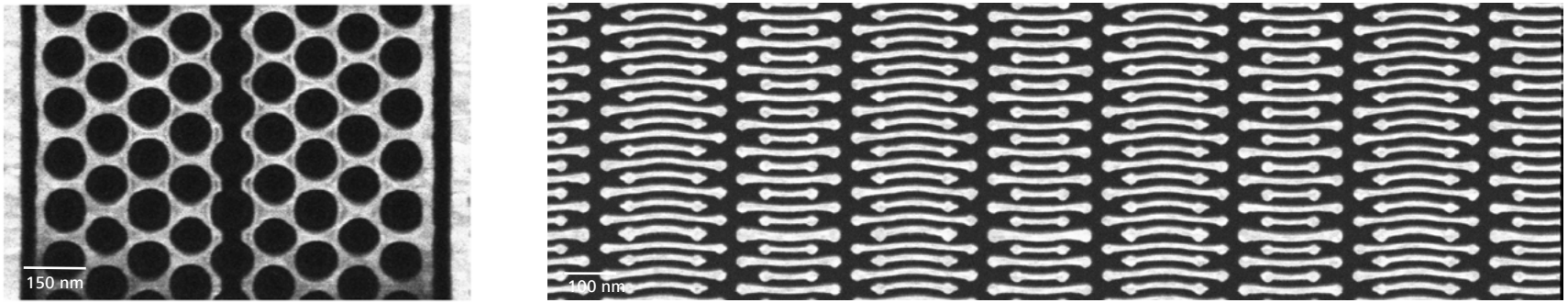
ZEISS Atlas 5 at Work

Semiconductor

XZ Plane, standard



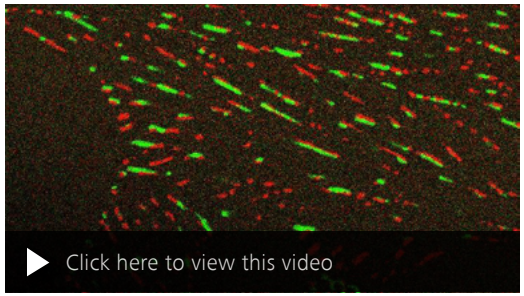
XZ Plane, True-Z



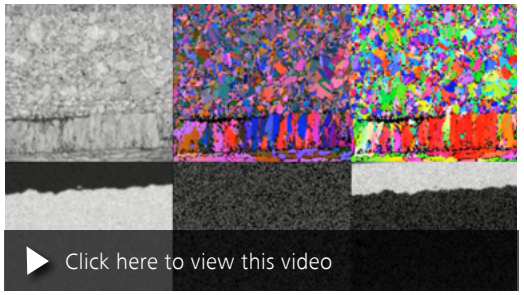
Two plan-view reconstructions of a 14 nm technology node commercially produced 3D NAND structure. The reconstruction benefits from the use of Atlas 5 3D Tomography's True-Z information on the measured thickness of every slice to more accurately reproduce the true dimensions of the 3D NAND. The virtual XZ plane of the reconstruction using the "standard" approach with a fixed nominal slice thickness (top) suffers from non-uniform thickness artifacts introduced by the room environment and other factors. After applying the direct slice information obtained using the True-Z technology, the structures observed in the reconstructed XZ plane are more consistently reproduced (bottom).

3D Analytics – EDS & EBSD

3D Tomography of a Multi-layered Metal System: 3D tomogram of a Canadian coin. The volume is 40 x 40 x 30 µm³ and the voxel size (20 nm)³. The SEM images were acquired at 2 kV with ZEISS Crossbeam and ZEISS Atlas 5.



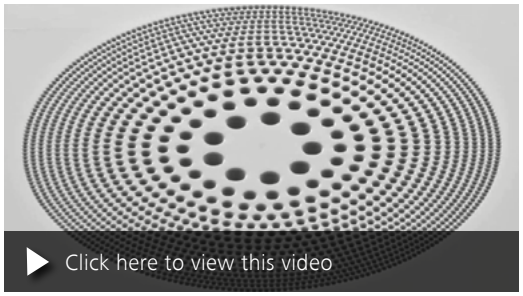
3D tomogram of lead-free solder using ZEISS Crossbeam. 3D Nanotomography data of a lead-free solder containing Cu and Ag particles in an Sn matrix. SEM images (top) and EDS maps (bottom) were acquired at the same sample site at 1.8 kV and 6 kV, respectively, using a ZEISS FIB-SEM and Atlas 5 Analytics. Courtesy of: M. Cantoni, EPFL Lausanne, Switzerland.



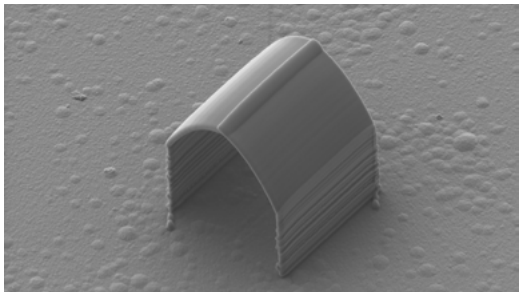
EDS and EBSD Investigations of a Multi-layered Metal System: Analytical investigations of a Canadian coin. EBSD (top) and EDS (bottom) maps of the same volume acquired at 15 kV. The maps were acquired at intervals of 200 nm. The experiment was performed with ZEISS Crossbeam, ZEISS Atlas 5 and EDS and EBSD system from Oxford Instruments.

ZEISS Atlas 5 at Work

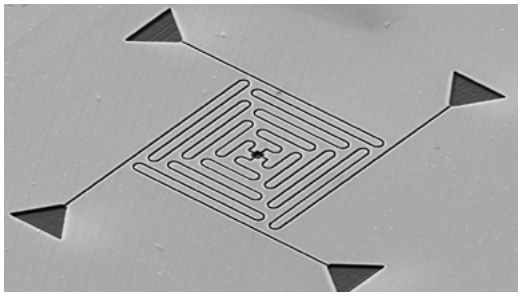
Nanopatterning



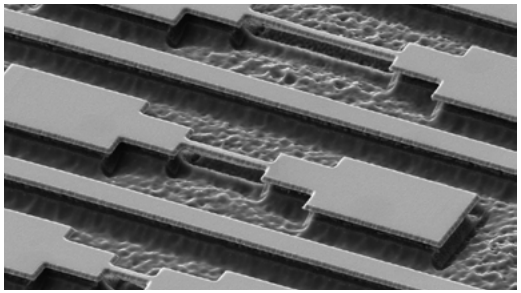
A sieve-style zone plate was nanofabricated using ZEISS Crossbeam and Atlas 5 NPVE Advanced. Atlas 5 acquired it as a single 32k × 24k pixel image and produced the movie.



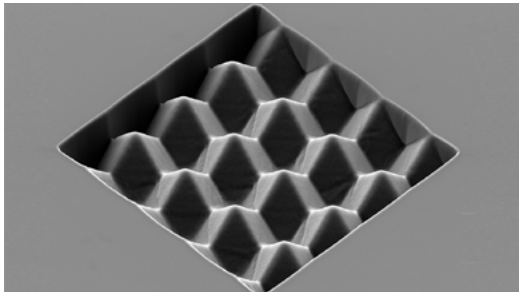
A 3D structure has been formed using NPVE Advanced and FIB deposition, field of view 14 µm.



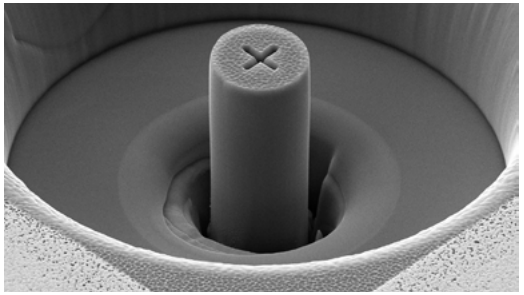
20 nm wide nano-channels in various configurations up to 20 µm in length are patterned with NPVE Advanced, field of view 59 µm.



Metal nanobridges on silicon, fabricated with Atlas 5 NPVE Advanced



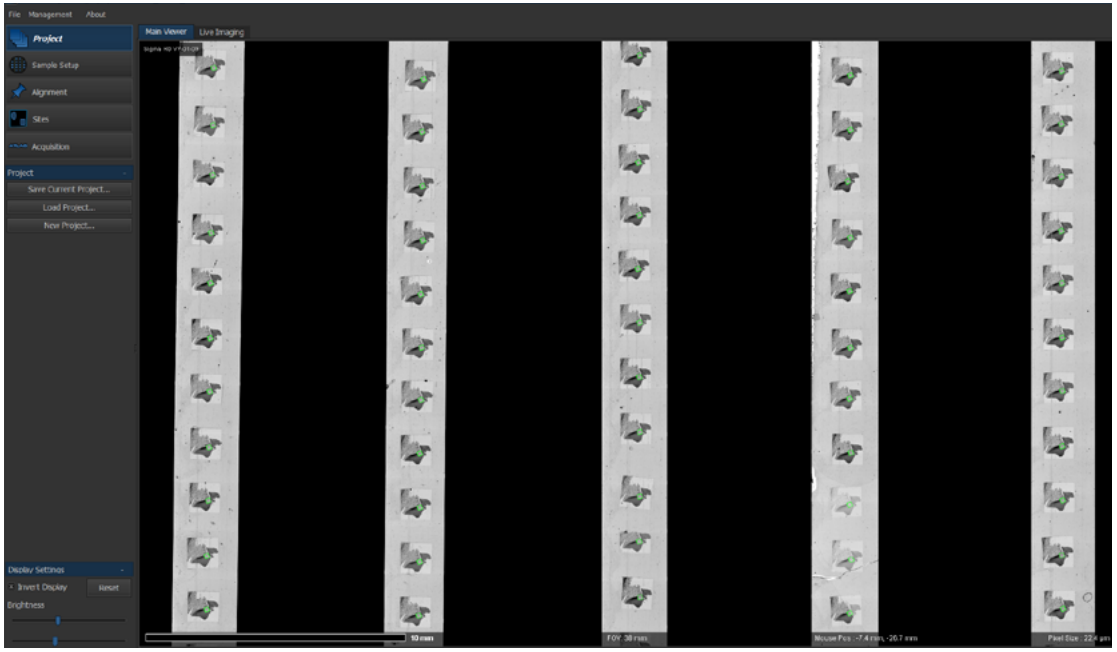
A three dimensional structure has been milled into a silicon wafer using the Atlas 5 NPVE Advanced module 3D-Profiler tool, field of view 30 µm.



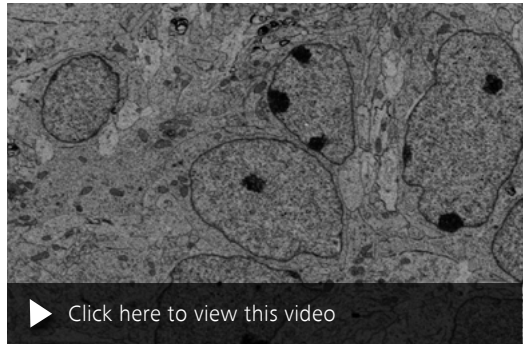
A parallel-sided cylinder with a central alignment mark is fabricated 'top-down' on ZEISS Crossbeam using Atlas 5 NPVE Advanced, field of view 40 µm.

ZEISS Atlas 5 at Work

Array Tomography



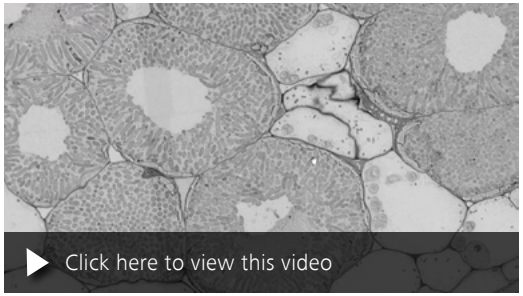
Serial ultrathin sections of a mouse brain prepared on a wafer with an automated tape collecting ultramicrotome. Choose specific areas in these sections and image them automatically at multiple resolutions using predefined or user-adjusted imaging protocols. Image corrections can be applied automatically to selected images or series of serial sections.
Sample: courtesy of J. Lichtman, Harvard University, USA.



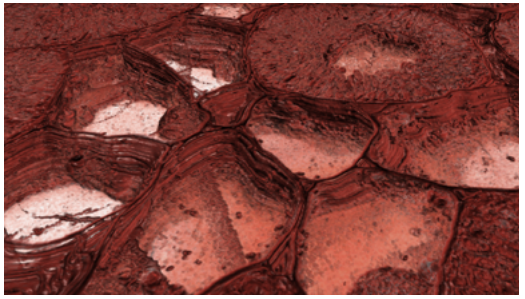
This animation shows the visualization of a selected area on an ultrathin section. It can be used for 3D reconstruction with commercially available software.

ZEISS Atlas 5 at Work

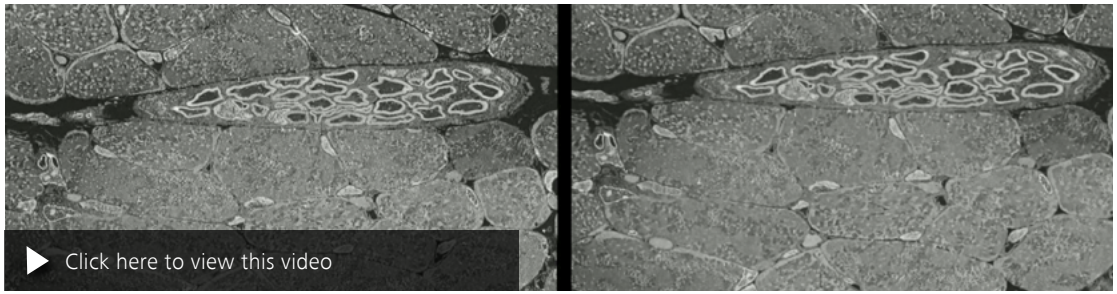
Array Tomography



Understand the symbiotic relationship of plants and bacteria in root nodules by visualizing the bacteria distribution in 3D. Images were taken with Atlas 5 Array Tomography.



The SEM image data stack from serial sections acquired automatically using Atlas 5 Array Tomography can be computed into a 3D model. Root nodules. Sample: courtesy of J. Sherrier, J. Caplan and S. Modla, University of Delaware, USA.



Array tomography on serial sections of mouse muscle tissue. A stack alignment algorithm enhances the results as it minimizes drift and compensates for rotation or displacements from section to section. The first 3D image stack is played without the alignment, showing the image sequence as acquired (left). The second stack shows the effects after application of the stack alignment (right). The experiment was performed with ZEISS Atlas 5 Array Tomography.

Your Flexible Choice of Components

ZEISS Atlas 5 Comes with Multiple Offerings

Get to know ZEISS Atlas 5's modules, their features and their configurability: Extend the capacity of your ZEISS SEM and FIB-SEM with Atlas 5 as an option. Benefit from advanced capabilities of further modules and learn how they are combined.

	SEM	FIB-SEM	Offline
Atlas 5	○	○	○
Array Tomography	○	○	○
Enhanced Browser-based Viewer Export	○	○	○
3D Tomography	×	○	○
NPVE Advanced	×	○	○
Analytics	*	**	×

○ option
× not configurable
* available for FE-SEMs
** available for Crossbeam

ZEISS Atlas 5: Modular Software Structure

ZEISS Atlas 5 Modular Structure	
Atlas 5	Workflow oriented high throughput acquisition platform. Fusion of images from multiple instruments, detectors and sessions in one correlative workspace. Import several image file types (BMP, JPG, TIF, CZI, TXM), flexible layered arrangement of images. Protocol based automated 2D acquisition. Large framestore up to 32k × 32k, 100ns, 8bit/16bit, 2 channels. xROI imaging (exact regions of interest). Manual stitching of 2D mosaics.
	Advanced Image Correction (gradient corrections, radial correction, per channel corrections),
	Advanced Automatic Stitching, Export to Movie. Optimize protocols per acquisition. Export multi-channel data by channel or as blends. Integrated image review in a guided review workflow. Efficient review of acquired 2D SEM data and automated reacquisition of problematic images.
Array Tomography	Tools for array tomography setup: Clone Tool for section definition, Snap Section tool for automated section definition, Site Management functions for efficient sub-site definition across sections. Image stack viewer and image stack export options, Batch Stitching, 3D Stack Alignment.
3D Tomography	3D FIB-SEM acquisition engine with automated sample preparation, exact region of interest (xROI) volume imaging, advanced sample tracking, adaptive slice thickness tracking, predictive drift correction and auto-tuning. Thin & Fast tomography method for tomogram acquisition, slice thickness measurement and improved visualization and data processing with True-Z information. Image stack viewer with FIB-SEM stack alignment, cropping and image stack export.
Analytics	Add 3D EDS/3D EBSD analytics to high resolution FIB-SEM tomography acquisition. Specify imaging and mapping conditions independently, including landing energy, dwell time and spatial resolution in all three dimensions. Advanced acquisition engine automatically switches between analysis and imaging conditions during acquisition. Flexible visualization allows simultaneous views of SEM images and processed elemental maps. 3D EBSD workflow possible in static and standard geometry hardware configuration. On FE-SEMs, integrate 2D EDS mappings into your workflow, select regions of interest (ROI) for 2D EDS mappings and automatically acquire multiple selected analytical ROIs.
Advanced NanoPatterning & Visualization Engine (NPVE Advanced)	Advanced control over patterning geometry and parameters. Simultaneous beam control with full patterning and imaging support for ion and electron beams. Operation recipes for smart control of beam and GIS parameters for consistent milling and deposition control over the widest range of conditions. Set operations, 3D profiles and array builder tools to optimize design of experiments. Include Fastmill, a special scanning strategy that allows faster and more efficient preparation of FIB cross-sections, saving up to 40% milling time.
Enhanced Browser-based Viewer Export	Export, analyze, present and share single or multiple datasets acquired with Atlas 5 or other modalities using a portable browser-based data format. Storyboarding of results and correlative datasets to present data in a comprehensive way by creating curated slide shows. Embedding of additional information like pdf files, images, movies or audio files. Enhanced visualization, annotation and measurement functionalities for exported datasets.

Atlas 5 modules require Atlas 5. Optional Analytics Module requires ZEISS Oxford Instruments hardware and software package. Analytics Module on FIB-SEM requires Atlas 5 3D Tomography.

Technical Specifications

Function	Headline
Image Characteristics	Continuously selectable up to 32k × 32k (50k × 40k on ZEISS Crossbeam family). Save image data as 8 or 16 bit TIFF files. Sample any available detector and record two detector signals simultaneously.
Dwell Time	Flexible, from 100 ns to >100 s per dwell point, continuously selectable for optimized imaging or patterning.
Autofocus & Auto-stigmation	Independent of FOV, image size and resolution, user tunable based on sample characteristics. Configurable to minimize impact on samples.
Exact Regions of Interest (xROIs)	Imaging in any shape: arbitrary polygonal, elliptical or rectangular regions, adjustable 'on the fly'. Direction of scan rotation adjustable to shape of site. Precise control of scanned image area.
Data Acquisition	Designed for automated acquisition of large field of view overview images and multi-image mosaics at multiple regions of interest. Sequential multi-job lists. Possible to resume and reacquire any desired region at any time, using the very same parameters. Predefined imaging protocols suitable for common sample types are provided.
Analytics	Offers advanced analytic capabilities embedded in an integrated correlative environment. Requires a specified package of Oxford Instruments components.
Correlative Approaches	Import of optical images for navigation, overlay and correlation of LM with EM data. Support for ZEISS Shuttle & Find correlative holders and for calibration is integrated. Import and correlate ZEISS 3D Laserscanning microscope multi-scale datasets. Import and correlate ZEISS 3D X-ray microscope volumetric datasets. Export to Browser based data format (in dedicated module).
Data Import/Export	Import 2D images from CZI, TIFF, JPG and BMP formats. Import ZEISS TXM 3D X-ray volumes. Import 3D image stacks from ZEISS Laser Scanning Microscopes. Export CZI, TIFF, JPG and MRC formats. Export at full resolution into CZI, raw format. Export to Browser based data format (in dedicated module).

Atlas 5 is available as option or field upgrade for ZEISS C-SEMs, FE-SEMs and FIB-SEMs. The retrofit must be performed by a service engineer who is authorized by ZEISS Research Microscopy Solutions.

Count on Service in the True Sense of the Word

Because the ZEISS microscope system is one of your most important tools, we make sure it is always ready to perform. What's more, we'll see to it that you are employing all the options that get the best from your microscope. You can choose from a range of service products, each delivered by highly qualified ZEISS specialists who will support you long beyond the purchase of your system. Our aim is to enable you to experience those special moments that inspire your work.

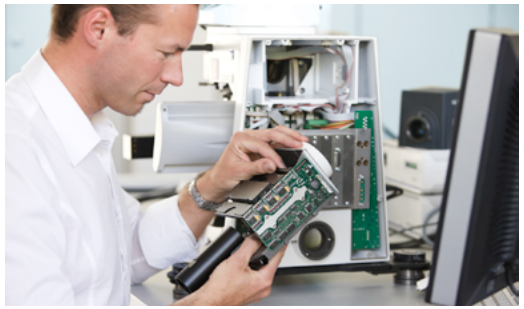
Repair. Maintain. Optimize.

Attain maximum uptime with your microscope. A ZEISS Protect Service Agreement lets you budget for operating costs, all the while reducing costly downtime and achieving the best results through the improved performance of your system. Choose from service agreements designed to give you a range of options and control levels. We'll work with you to select the service program that addresses your system needs and usage requirements, in line with your organization's standard practices.

Our service on-demand also brings you distinct advantages. ZEISS service staff will analyze issues at hand and resolve them – whether using remote maintenance software or working on site.

Enhance Your Microscope System.

Your ZEISS microscope system is designed for a variety of updates: open interfaces allow you to maintain a high technological level at all times. As a result you'll work more efficiently now, while extending the productive lifetime of your microscope as new update possibilities come on stream.



Profit from the optimized performance of your microscope system with services from ZEISS – now and for years to come.

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